



1995-96 KIRIS OPEN-RESPONSE ITEM SCORING WORKSHEET

Grade 11 — Science Question 6

The academic expectations applied in this item include:

2.1 Students understand scientific ways of thinking and working and use those methods to solve real-life problems.

2.4 Students use the concept of scale and scientific models to explain the organization and functioning of living and nonliving things and predict other characteristics that might be observed.

The core content assessed by this item includes:

Process

- Logic and evidence are used to formulate and revise scientific explanations and models.
- Scientific explanations must adhere to criteria.

Content

- The Molecular Basis of Heredity
 - * In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA.

6. Genetic Analysis

Kiley's cat had a litter of kittens. Kiley did some research and learned the following information about cat genetics:

<u>Hair color in cats</u>	<u>Number of toes on front feet of cats</u>
B (dominant allele) produces black hair	T (dominant allele) produces 6 toes
b (recessive allele) produces brown hair	t (recessive allele) produces 5 toes

Kiley then examined her cat and the kittens. She produced the data found on the chart below:

<u>Cat</u>	<u>Hair Color</u>	<u>Number of Toes</u>
mother	black	6
kitten #1	black	6
kitten #2	black	6
kitten #3	black	5
kitten #4	black	5
kitten #5	brown	6
kitten #6	brown	6
kitten #7	brown	5
kitten #8	brown	5

Analyze the data recorded by Kiley. Based on this information, what can you tell about the parent cats' genes for hair color and number of toes? Explain how you know this.

SCORING GUIDE

Score	Description
4	<p>Student response does not contain errors.</p> <p>A. Student analyzes the data and tells the mother's genotype and the father's possible genotypes.</p> <p>B. Student gives a correct, detailed explanation about why the mother can have only one genotype and about why the father's genotype can not be defined, only narrowed down.</p>
3	<p>Student response contains minor errors.</p> <p>A. Student analyzes the data and tells the mother's genotype and the father's possible genotypes.</p> <p>B. Student gives a good explanation about why the mother can have only one genotype and may explain why the father's genotype can not be defined, only narrowed down.</p>
2	<p>Student response contains minor errors.</p> <p>Student gives some explanation of possible genotypes for the mother and/or father.</p>
1	<p>Student response contains errors.</p> <p>Student gives minimal explanation of possible genotypes for the mother and father that does not display a working knowledge of genetics.</p>
0	Response is incorrect or irrelevant.
Blank	Blank/no response.

Background Information Based On The Analysis Of The Given Data:

- The mother's genotype (i.e. genetic constitution) must be BbTt. She exhibits the dominant traits, but she has offspring who exhibit recessive traits; therefore, she must possess both genes herself.
- The father's genotype cannot be defined, only narrowed down. He must have one recessive gene for each trait because his offspring exhibit the recessive traits. However, we do not have information on his phenotype (i.e. visible properties or traits) so we can not define his genotype. The possible genotypes for the father are:
BbTt or Bbtt or bbTt or bbtt
- The number of offspring in this litter is too limited to make definite assumptions based on the phenotypes of the offspring. Some students may do several dihybrid crosses and state which cross most closely resembles the ratios derived by this method, i.e. BbTt x bbtt.
 GENOTYPE = Ratio of black/6 toes: black/5 toes: brown/6 toes: brown/5 toes
 BbTt x BbTt = 9:3:3:1
 BbTt x Bbtt = 6:6:2:2
 BbTt x bbTt = 6:2:6:2
 BbTt x bbtt = 4:4:4:4



KIRIS ASSESSMENT ANNOTATED RESPONSE

GRADE 11 SCIENCE

Sample 4-Point Response of Student Work

Student analyzes the data and tells the mother's genotype and the father's possible genotypes. Notice that the student makes an error by stating "the father **had** to carry a dominant and recessive gene". The student then corrects the error by giving other possible genotypes for the father.

Student explains why the mother can have only one genotype and the father's genotype **cannot** be defined, only narrowed down.

Student demonstrates an ability to formulate and revise scientific explanations and models using logic and evidence.

Kiley's cat had the dominant gene for both hair color and number of toes. She produced offspring, $\frac{3}{4}$ of which exhibited the recessive trait for hair color, number of toes, or both. Only two of her kittens had the dominant trait for hair color and number of toes. Genes of a recessive trait must be passed onto the offspring from both parents for that offspring to exhibit the trait. Therefore, the mother had to carry a dominant and recessive gene for each characteristic and the father had to carry a dominant and recessive gene for each characteristic. It is also possible that the father carried two recessive genes for one or both of the characteristics. The mother had to have one dominant gene for each characteristic.

Student demonstrates an application of scientific ways of thinking and working and uses those methods to solve real-life problems.

Student demonstrates an understanding that scientific explanations must be based on scientific knowledge.

Student demonstrates a knowledge that in all organisms, the instructions for specifying the characteristics of the organisms are carried in DNA.

Student demonstrates an application of scale and scientific models to explain the organization and functioning of living and nonliving things and predict other characteristics that might be observed.



KIRIS ASSESSMENT ANNOTATED RESPONSE

GRADE 11 SCIENCE

Sample 2-Point Response of Student Work

Student demonstrates some ability to formulate and revise scientific explanations and models using logic and evidence.

Student gives some explanation of possible genotypes for the mother and father.

Student demonstrates some understanding that scientific explanations must be based on scientific knowledge.

Both parents probably had Bb and Tt genes, although one parent could possibly have had both recessive genes for hair color and number of toes. It takes a recessive gene from both parents to produce offspring with that recessive trait, and it only takes one dominant gene to produce offspring with that trait. For a cat to have brown hair and five toes, it must receive a “b” and a “t” allele from both parents.

Student demonstrates some application of scientific ways of thinking and working and uses those methods to solve real-life problems.

Student demonstrates some knowledge that in all organisms, the instructions for specifying the characteristics of the organism are carried in DNA.

Student demonstrates some application of scale and scientific models to explain the organization and functioning of living and nonliving things and predict other characteristics that might be observed.

Sample 1-Point Response of Student Work

Student explanation is minimal and contains major errors.

The mother has dominant genes. The kittens are evenly broken up into dominant and recessive. So maybe the father is recessive. I don't really know this. Its just by looking at the data. Its what I've come to my own conclusion.



KIRIS ASSESSMENT ANNOTATED RESPONSE

GRADE 11 SCIENCE

Sample 3-Point Response of Student Work

Student analyzes the data and tells the mother's genotype and the father's possible genotypes.

Student explains why the mother can have only one genotype, but the explanation of the father's genotype contains errors.

Based on Kiley's research B, the dominant allele, produces black hair and b, the recessive allele produces brown hair color in cats. Also T, the dominant allele, produces 6 toes and t, the recessive allele, produces 5 toes on the front feet of cats. Kiley's mother cat has black hair and 6 toes on her front feet. This means that the cat could be homozygous dominant for both the black hair and the six toes or heterozygous for the above traits. There is no way to determine which she is unless you look at the phenotype of the kittens, or how they appear. Four of the kittens are brown, which requires two recessive alleles. This means that the mother cat must be heterozygous for this trait. Four of the kittens also have 5 toes which requires two recessive alleles. This means that the mother must also be heterozygous for this trait. Because only one parent can give one allele from each gene the father must also be either heterozygous for both traits or must be homozygous recessive for both traits. The only way to determine which the father is, is to do a test cross using a punet square. The mother's genotype is BbTt and the father's is BbTt or bbtt. I will do two punet squares, one with each father. To do a test cross you take the mother's possible gametes formed with that of the father.

Test Cross #1		BT	Bt	bt	bT	
Mother	Father #1	BT	BBTT	BBTt	BbTt	BbTT
	Bt	BBTt	BBtt	Bbtt	BbTt	BbTt
	bt	BbTt	Bbtt	bbtt	bbTt	bbTt
	bT	BbTT	BbTt	bbTt	bbTT	bbTT

Test Cross #2		bt	bt
Mother	Father #2	BT	BbTt
		BbTt	BbTt
		Bbtt	Bbtt
		bbtt	bbtt
	bT	bbTt	bbTt

The square with lines drawn through them are repeats of the same genotype. The results of the first test cross did not produce the same phenotype as the kitten in the graph. However, the phenotype for the second test cross is the same as the kittens in the graph. So by this information we know that the father has brown hair and 5 toes. This, by using a punet square and genetics knowledge I know that the mother cat is BbTt or black with 6 toes and the father is bbtt or brown with 5 toes.

Student demonstrates an understanding that scientific explanations must be based on scientific knowledge.

Student demonstrates an ability to formulate and revise scientific explanations and models using logic and evidence.

Student demonstrates an application of scale and scientific models to explain the organization and functioning of living and nonliving things and predict other characteristics that might be observed.

Student demonstrates a knowledge that in all organisms, the instructions for specifying the characteristics of the organism are carried in DNA.

Student demonstrates an application of scientific ways of thinking and working and uses those methods to solve real-life problems.

INSTRUCTIONAL STRATEGIES

Genetic Analysis

Students design, build, label, and explain a cell model and its parts.

Students compare various visible characteristics of at least three generations of family members (e.g., hair color, eye color, earlobe attachment, nose shape, etc.), record and chart their observations, then develop a model of family heredity.

Students research Gregor Mendel and report on his contributions to the study of genetics.

Students use a Punnett square to determine the probability that an unborn child will be a girl. Students could use the facts that a mother contributes two X chromosomes and a father contributes an X and a Y chromosome.

Students research hemophilia, cystic fibrosis, color blindness, or sickle-cell anemia and report what role genetics plays in their occurrence.

Students research the Human Genome Project and report on how the project may be useful and some controversies it may raise.

Students practice scoring open response items by using released KIRIS items, released scoring guides, and photocopied student responses.